Solutions: Case C→Q Checkpoint

The first two questions refer to the following information:

A Canadian study measuring depression level in teens (as reported in the *Journal of Adolescence*, vol. 25, 2002) randomly sampled 112 male teens and 101 female teens, and scored them on a common depression scale (higher score representing more depression). The researchers suspected that the mean depression score for male teens is higher than for female teens, and wanted to check whether data would support this hypothesis.

Question 1

If μ_1 and μ_2 represent the mean depression score for male teens and female teens respectively, which of the following is the appropriate pair of hypotheses in this case?

Select one answer.
10 points

(a)

$$H_0: \mu_1 - \mu_2 = 0$$
$$H_a: \mu_1 - \mu_2 < 0$$

(b)

$$H_0: \mu_1 - \mu_2 > 0$$
$$H_a: \mu_1 - \mu_2 = 0$$

(c)

$$H_0: \mu_1 = \mu_2$$
$$H_a: \mu_1 > \mu_2$$

(d)

$$H_0: \mu_1 - \mu_2 = 0$$
$$H_a: \mu_1 - \mu_2 > 0$$

(e) Both (c) and (d) are correct.

Correct answer: (e)

Question 2

The following is the (edited) output for the test:

Select one answer.
10 points

Two-Sample T-Test and CI

```
Sample     N  Mean  StDev  SE Mean
1(M)     112  7.38   6.95     0.66
2(F)     101  7.15   6.31     0.63


Difference = mu (1) - mu (2)
Estimate for difference:  0.230000
95% lower bound for difference:  -1.271079
T-Test of difference          :  T-Value = 0.25  P-Value = 0.400  DF = 210
```

From the output we learn that:

(a) the data provide sufficient evidence to reject H_0 and to conclude that the mean depression score for male teens is larger than that of female teens.

(b) the data provide sufficient evidence to conclude that male and female teens do not differ in mean depression score.

(c) the data do not provide sufficient evidence to conclude that the mean depression score of male teens is larger than that of female teens.

(d) the data do not provide sufficient evidence to reject H_0, so we accept it, and conclude that male and female teens do not differ in mean depression score.

Correct answer: (c)

Grain is fortified with vitamins at the factory when processed. But, before the product reaches the consumer, some of the vitamins may degrade due to time, heat during storage, etc. Suppose the vitamin contents (in milligrams per pound) of five bags of grain are measured at the factory before shipping, and then again at the retail store after shipping. The results are as shown:

Bag	Vitamin content before shipping	Vitamin content after shipping
1	45	38
2	47	45
3	48	48
4	38	35
5	48	39

We wish to test whether there is a statistically significant decrease in vitamin content after shipping.

Question 3

Given the design of the study and the question of interest, which of the following 4 computer outputs is relevant to use?

Select one answer.
10 points

(a)

Paired T-Test and CI: before shipping, after shipping

```
Paired T for before shipping - after shipping

                 N     Mean    StDev  SE Mean
before shipping  5  45.2000   4.2071   1.8815
after shipping   5  41.0000   5.3385   2.3875
Difference       5  4.20000  3.70135  1.65529


95% lower bound for mean difference: 0.67117
T-Test of mean difference = 0 (vs > 0): T-Value = 2.54  P-Value = 0.032
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(b)

Two-Sample T-Test and CI: before shipping, after shipping

```
Two-sample T for before shipping vs after shipping

                 N   Mean  StDev  SE Mean
before shipping  5  45.20   4.21      1.9
after shipping   5  41.00   5.34      2.4


Difference = mu (before shipping) - mu (after shipping)
Estimate for difference:  4.20000
95% lower bound for difference:  -1.55902
T-Test of difference = 0 (vs >): T-Value = 1.38  P-Value = 0.105
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(c)

Paired T-Test and CI: before shipping, after shipping

```
Paired T for before shipping - after shipping

                 N     Mean    StDev  SE Mean
before shipping  5  45.2000   4.2071   1.8815
after shipping   5  41.0000   5.3385   2.3875
Difference       5  4.20000  3.70135  1.65529


95% upper bound for mean difference: 7.72883
T-Test of mean difference = 0 (vs < 0): T-Value = 2.54  P-Value = 0.968
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(d)

Two-Sample T-Test and CI: before shipping, after shipping

```
Two-sample T for before shipping vs after shipping

                 N   Mean  StDev  SE Mean
before shipping  5  45.20   4.21      1.9
after shipping   5  41.00   5.34      2.4


Difference = mu (before shipping) - mu (after shipping)
Estimate for difference:  4.20000
95% upper bound for difference:  9.95902
T-Test of difference = 0 (vs <): T-Value = 1.38  P-Value = 0.895
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Correct answer: (a)

The next three questions refer to the following information:

To determine the relative effectiveness of different study strategies for the SAT, suppose three groups of students are randomly selected: One group took the SAT without any prior studying; the second group took the SAT after studying on their own from a common study booklet available in the bookstore; and the third group took the SAT after completing a paid summer study session from a private test-prep company. The means and standard deviations of the resulting SAT scores from this hypothetical study are summarized below:

	n	$\bar{x}$	s
Group 1 (no study)	12	1014.1	4.9
Group 2 (personal study)	12	1015.8	5.1
Group 3 (paid preparation)	9	1023.7	5.7

Since we are comparing more than 2 groups, we will use ANOVA to test whether the data provide evidence that SAT score is related to study strategy.

Question 4

If we let μ_1, μ_2, and μ_3 be the mean SAT scores for students who use learning strategies 1, 2, and 3, respectively, the appropriate hypotheses in this case are:

Select one answer.
10 points

(a)

$$H_0: \mu_1 = \mu_2 = \mu_3$$
$$H_a: \mu_1 \neq \mu_2 \neq \mu_3$$

(b)

$$H_0: \mu_1 \neq \mu_2 \neq \mu_3$$
$$H_a: \mu_1 = \mu_2 = \mu_3$$

(c)

$$H_0: \mu_1 = \mu_2 = \mu_3$$
$$H_a: \mu_1, \mu_2, \mu_3 \text{ are not all equal}$$

(d)

$$H_0: \mu_1, \mu_2, \mu_3 \text{ are not all equal}$$
$$H_a: \mu_1 = \mu_2 = \mu_3$$

(e) Both (a) and (c) are correct.

(f) Both (b) and (d) are correct.

Correct answer: (c)

Question 5

One of the conditions that allows us to use ANOVA safely is that of equal (population) standard deviations. Can we assume that this condition is met in this case?

Select one answer.
10 points

(a) No, since the three sample standard deviations are not all equal.

(b) No, since the population standard deviations are not given, so we cannot check this condition.

(c) Yes, since 5.7 - 4.9 < 2.

(d) Yes, since 5.7 / 4.9 < 2.

Correct answer: (d)

Question 6

Using the following output:

Select one answer.
10 points

Analysis of Variance for SAT

```
         DF      SS        MS       F         P
Group     2   625.2     312.6   11.43     0.000
Error    30   820.7      27.4
Total    32  1445.9
```

we can conclude that:

(a) the data provide strong evidence that SAT scores are related to learning strategy.

(b) the data provide strong evidence that SAT scores are related to learning strategy in the following way: The mean SAT score for students who pay for coaching is higher than the mean SAT score for students who study themselves, which in turn is higher than that of students who do not study for the test.

(c) the data provide strong evidence that the three mean SAT scores (representing the three learning strategies) are not all equal.

(d) the data do not provide sufficient evidence that SAT scores are related to learning strategy.

(e) Both (a) and (c) are correct.

Correct answer: (e)

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